Dr. Jerry Hausman
Economic Foundations

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of Petition of WorldCom, Inc. Pursuant to Section 252(e)(5) of the Communications Act for Expedited Preemption of the Jurisdiction of the Virginia State Corporation Commission Regarding Interconnection Disputes with Verizon Virginia Inc., and for Expedited Arbitration	)	CC Docket No. 00-218
In the Matter of Petition of Cox Virginia Telecom, Inc., etc.	)	CC Docket No. 00-249
In the Matter of Petition of AT&T Communications of Virginia Inc., etc.	)	CC Docket No. 00-251

VERIZON VIRGINIA INC.

REBUTTAL TESTIMONY OF PROF. JERRY HAUSMAN ON ECONOMIC FOUNDATIONS

AUGUST 27, 2001

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II. INTRODUCTION (JDPL ISSUES II-1-A TO II-1-C; II-2-A TO II-2-C)

Q. Please state your name and business address.

A. My name is Jerry A. Hausman. I am the MacDonald Professor of Economics at the Massachusetts Institute of Technology in Cambridge, Massachusetts, 02139.

Q. Please state your educational background and areas of teaching and research.

A. I received an A.B. degree from Brown University and a B.Phil. and D. Phil. (Ph.D.) in Economics from Oxford University where I was a Marshall Scholar. My academic and research specialties are econometrics, the use of statistical models and techniques on economic data, and microeconomics, the study of consumer behavior and the behavior of firms. I teach a course in "Competition in Telecommunications" to graduate students in economics and business at MIT each year. I am also the director of the MIT Telecommunications Economics and Business Research Program. I was a member of the editorial board of the *Rand* (formerly the *Bell*) *Journal of Economics* for the past 13 years. The *Rand Journal* is the leading economics journal of applied microeconomics and regulation. In December 1985, I received the John Bates Clark Award of the American Economic Association for the most "significant contributions to economics" by an economist under forty years of age. I have received numerous other academic and economic society awards. A copy of my curriculum vitae is attached as Attachment A..

Q. Please describe your prior experience in telecommunications research.

A. I have done significant amounts of research in the telecommunications industry. My first experience in this area was in 1969 when I studied the Alaskan telephone system for the

Army Corps of Engineers. Since that time, I have studied many areas of telecommunications. My recent academic papers in telecommunications include (1) "Taxation By Telecommunications Regulation," *Tax Policy and the Economy* (1998); (2) "Economic Welfare and Telecommunications Welfare: The E-Rate Policy for Universal Service Subsidies," (with H. Shelanski), *Yale Journal on Regulation* (1999); (3) "A Consumer-Welfare Approach to the Mandatory Unbundling of Telecommunications Networks," (with J. Gregory Sidak) *Yale Law Journal* (1999); (4) "Efficiency Effects on the U. S. Economy from Wireless Taxation," *National Tax Journal* (2000); (5) "Competition in U.S. Telecommunications Services Four Years After the 1996 Act," (with R. Crandall), in S. Peltzman and C. Winston, eds., *Deregulation of Network Industries* (2000); (6) "Residential Demand for Broadband Telecommunications and Consumer Access to Unaffiliated Internet Content Providers," (with H. Sider and J.G. Sidak), *Yale Journal on Regulation* (2001); and (7) "Cable Modems and DSL: Broadband Internet Access for Residential Customers," (with J. Gregory Sidak, and Hal J. Singer), *American Economic Review* (2001).

Q. Your testimony deals with the effect of sunk costs in setting rates for unbundled elements. Have you published in this area?

A. Yes. My papers in this area include: (1) "Valuation and the Effect of Regulation on New Services in Telecommunications," *Brookings Papers on Economic Activity: Microeconomics* (1997); (2) "Regulation by TSLRIC: Economic Effects on Investment and Innovation," *Multimedia Und Recht* (1999) (also in J.G. Sidak, C. Engel, and G.

Knieps eds., *Competition and Regulation in Telecommunications*, (2000)); (3) "The Effect of Sunk Costs in Telecommunication Regulation," in J. Alleman and E. Noam, eds., *The New Investment Theory of Real Options and its Implications for Telecommunications Economics* (1999); and (4) "Regulated Costs and Prices in Telecommunications," forthcoming *International Handbook of Telecommunications* (2001).

Q. Have you provided testimony before state or federal regulatory bodies on the topic of telecommunications policy?

A. I have testified numerous times before the California Public Utilities Commission (CPUC). I have also submitted declarations numerous times to the FCC and participated in FCC forums on interconnection regulation and other issues.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to analyze the effect that adoption of AT&T/WorldCom's Modified Synthesis Model (the MSM model) would have on a carrier's investment costs in light of the risk and economic depreciation adjustments that would be necessary as a result of that model's assumptions.

Q. What are the principal conclusions of your analysis?

A. Sunk and irreversible investment is an extremely important economic factor in telecommunications networks. Sunk investments are investments that cannot be

redeployed if the project is not successful. Thus, if future demand is lower than expected or output prices are lower than expected, sunk investments cannot be redeployed to another use where their economic return (profits) are at the market rate of return. Many TELRIC models do not allow for sunk costs, but instead make the incorrect assumption that all investments can be redeployed at any time in the future. Also, prices for many network elements, *e.g.*, fiber optics, have been decreasing over the past decade. These price decreases should be included in a correct economic model through economic depreciation. Again, many TELRIC models do not allow for economic depreciation so that they assume, contrary to fact, that prices for network equipment will not decrease, despite rapid advances in technology. The problem is particularly acute with the MSM model because of its extreme assumptions of replacing an entire network instantaneously, perfectly sized with the most efficient technology at the time – and then doing it all over again in a few years when prices are re-set. To take account of the effect of sunk costs, the estimated TELRIC values in any instantaneous replacement model such as the MSM model (after being corrected to remedy the additional deficiencies identified by Dr. Tardiff, Mr. Murphy, and other Verizon VA witnesses) would need to be increased by factors on the order of 97% to 120%, depending on the particular element and the proportion of sunk costs to the total costs of providing the element.

II. ANALYSIS (JDPL ISSUES II-1-A to II-1-C; II-2-A TO II-2-C)

Q. What is the basic modeling approach taken by the AT&T/WorldCom Modified Synthesis Model?

A. I understand from Dr. Tardiff's testimony that AT&T/WorldCom's Modified Synthesis Model (MSM) assumes the instantaneous deployment of a new network that replaces Verizon VA's existing network facilities in their entirety. As Ms. Murray describes, AT&T and WorldCom operate from the premise that a UNE cost model should "assume[] away" all existing facilities and instantaneously replace them with what are assumed to be the most efficient available technologies.[1/] Moreover, the model hypothesizes that this new replacement network is built and sized to serve existing demand. Thus, the MSM model assumes away all risk and uncertainty about what the actual level of demand will be in the future. In essence, this "instantaneous" aspect allows the Modified Synthesis Model to take a snapshot of the world at the time the model is run and attempt to calculate the costs of an idealized network built to serve the static conditions reflected in that snapshot. All risk and uncertainty is assumed away, which is inconsistent with how the actual world operates.

In addition, the MSM repeats this process every three to four years (depending upon how often prices are re-set), building an entirely new, perfectly sized network using the most efficient technology, regardless of what it viewed as the "perfect" network the

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1/ Direct Testimony of Ms. Terry Murray at 46.

last time around. This "successive" aspect to the MSM model only exacerbates the problems with its "instantaneous" aspect. Thus at a minimum, depreciation rates in the MSM model would need to be extremely high given the assumed three to four year replacement cycle. In effect, the MSM model assumes that all the current network plant becomes stranded after several years, when it is replaced by the newest and most efficient technology that exists. I find the assumptions of the MSM model to be extreme and unrealistic.

Q. What is the economic basis for the MSM approach to forward-looking costs?

A. Because the MSM model makes no allowance for the sunk and irreversible nature of telecommunications investment, it is based on the "perfect contestability" model of competition. Sunk investments are investments that cannot be redeployed if the project is not successful. The "perfect contestability" model of competition assumes away the existence of sunk costs. Thus, the perfect contestability model is not correct for the economic analysis of telecommunications networks where a substantial proportion of total investment is sunk investment. The MSM model makes the assumptions that investment costs are fixed, but not sunk, so that the capital assets can be redeployed in other uses if technology advances or other economic events decrease the return on the assets.

Q. Please explain the difference between a fixed cost and a sunk cost.

A. A fixed cost is a cost that must be incurred in a given period to produce a good or service. However, in the next period if the service is not produced, the fixed cost is not incurred. To the contrary, a sunk cost cannot be avoided in the next period; indeed, the sunk component of the investment cannot be recovered if the service stops. Thus, investment that is fixed but not sunk can be redeployed the next period to another production process at relatively low cost. An example is a PC that can be reused. However, specialized software that is written for the particular project and cannot be reused in another project would be an example of a sunk cost. In telecommunications much network investment is sunk, such as investment in fiber optic networks or additional residential loops.

Q. Can you give an example of the importance of sunk investments and its relation to the MSM model calculations?

A. Consider the investment by an incumbent local exchange carrier (ILEC) in a new local fiber optic network, which can provide new broadband services and high speed Internet access to residential customers. Much of the investment is sunk since if the broadband network does not succeed, if demand is not as high as forecast, or if prices decrease more than forecast, and the return on investment falls below the competitive return, the investment cannot be recovered. In a "perfectly contestable" market, to the contrary, if the return on an investment decreases below the competitive return, the investment is immediately removed from the market and used elsewhere. This costless exit strategy is always available in a perfectly contestable market. However, the actual economics of

telecommunications investment could not be further from a perfectly contestable market. If the economic return falls below competitive levels, the firm cannot shift the investments to other uses because of their sunk and irreversible nature. Thus, the use of a perfectly contestable market standard fails to recognize the important feature of sunk and irreversible investments — they eliminate costless exit. Because of its failure to take into account the sunk and irreversible nature of much telecommunications investment, the contestable market model does not correctly capture an extremely important factor in the economics of telecommunications networks.[2/]

More generally, much of the ILEC network plant faces the risk of further advances in wireless telecommunication. In particular, current 3G technology, which is now being implemented, is expected to offer high quality voice and high speed data services that may decrease demand and prices for services offered over the ILEC network during a reasonable forward-looking period. This change in technology creates significant risk. The MSM model assumes that no technology risk exists.

[2/] The contestable model of competition has been highly criticized as being unrelated to real world situations. Previous criticisms of its attempted application to telecommunications include Armstrong and Vickers (1995): "In fact, of course, the industry does not remotely resemble a contestable market . . . ." *See* Mark Armstrong & John Vickers, "Regulation in Telecommunications," in *The Regulatory Challenge*, at 304 (M. Bishop, J. Kay, & C. Meyer eds., 1995).

Q. What is the economic effect of the MSM model adopting the perfect contestability standard instead of recognizing the importance of sunk and irreversible investment in telecommunications networks?

A. Failure to recognize the sunk cost character of much network investment leads to the grant of a *free option* to the competitors of the regulated incumbent. An option is the right but not the obligation to purchase the use of the unbundled elements. Options are typically worth significant amounts of money because they permit an action to occur when economic times are good, but not when economic times are bad. They decrease the risk for the holder of the option by a significant amount. Causing the shareholders of the incumbent firm to fund the free option for the competition will lead to underinvestment by *both* the incumbent and the new competitors. The incumbent underinvests because it will not achieve (on average) a sufficient return to justify marginal investments due to the grant of the free option to its competitors. The new competitors, who receive the free option, will underinvest in facilities because of the subsidy they receive with the grant of the free option. Given the amount of uncertainty in a dynamic industry with rapidly changing technology and economics, conferring a free option can have an especially large effect on investment incentives because the value of the option is high.

Q. Have AT&T and its economists recognized, in print, that sunk costs and real options must be taken into account?

A. Yes, in the Alleman and Noam (1999) conference volume on real options, Professor William Baumol (a long time economic consultant and witness for AT&T), as well as Dr.

Richard Clarke (an internal AT&T economist), both make this recognition. Professor Baumol, an inventor of contestability theory and a previous supporter of the TELRIC approach to regulation, has recognized that sunk costs must be considered in a proper regulatory approach owing to the "profound implications for both theory and practice."[3/] Because Professor Baumol was an inventor of TSLRIC (which mutated into the TELRIC approach) and supported the use of TSLRIC and TELRIC when the FCC decided on its current form of regulation in 1996,[4/] his recognition that sunk costs are an important economic factor that cannot be ignored is potentially quite significant. Professor Baumol now states that a cost component in the investment decision has been overlooked, "so that the total costs of such decisions (and hence their appropriate price) is normally underestimated."[5/] This recognition is equivalent to the granting of the free option to competitors by failing to take account of the sunk costs. Professor Baumol goes on to say:

> The error cannot be cured without including the value of the foregone options as part of the cost of an immediate or early commitment. Thus, the true total costs of the investment are higher than they usually are calculated to be. Moreover, the true *marginal* cost of increased investment can also be expected to be higher than it is usually estimated to be.[6/]

[3/] See William J. Baumol, "Option Value Analysis and Telephone Access Charges", in *The New Investment Theory of Real Options and its Implications for Telecommunications Economics*, at 215 (J. Alleman and E. Noam, eds., 1999).

[4/] *See* Affidavit of W. Baumol, J. Ordover, and R. Willig on behalf of AT&T in FCC CC Docket No. 96-98 (July 1996).

[5/] Baumol, *supra* n.3, at 215.

[6/] *Id.* at 216.

Thus, Professor Baumol and I now agree that the options value of investment is a real cost that regulators must take account of if they are to make the correct decisions. Dr. Richard Clarke, an economist at AT&T responsible for development of AT&T's economic policy related to the provision of local telephone services, stated in the Alleman and Noam conference volume that "real options theories are valid . . . ."[7/] While Dr. Clarke disagrees with my parameter estimates, nevertheless, he also recognizes that sunk costs and real options are an important component of investment in telecommunications networks.

Thus, economists who have worked (and currently work) for AT&T have now recognized the importance of sunk costs and that TELRIC estimates are too low if they ignore the effect of sunk costs.

Q. What are the explicit economic assumptions that the MSM model calculations make?

A. The MSM model calculations makes the following assumptions: (1) the investment is always used at planned capacity, (2) the demand curve does not shift inwards over time, and (3) a new or improved technology does not appear that leads to lower cost of

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7/ Dr. Richard N. Clarke, "Rethinking the Implications of 'Real Options' Theory for the U.S. Local Telephone Industry," in *The New Investment Theory of Real Options and its Implications for Telecommunications Economics*, at 219-24 (J. Alleman and E. Noam eds., 1999).

production. Of course, these conditions are unlikely to hold true over the lifetime of the sunk investment. The MSM model makes the assumption that no uncertainty exists in the outcomes over the life of the investment. Thus uncertainty needs to be added to the calculation because of the sunk nature of much of the investment.

Q. What is the first category of costs that the AT&T/WorldCom MSM model calculations miss?

A. The calculations that I have described omit the change in price of capital goods, which is an element of economic depreciation, used to provide the service. Consider the value of a project under no demand uncertainty with a risk adjusted discount rate of r and assumed known exponential economic depreciation at rate δ.[8/] This assumption on depreciation can be thought of, in part, as the price of the capital decreasing over time at this rate due to technological progress. Assume that price, net of the effect of economic depreciation of the capital goods, is expected to decrease with growth rate $-\alpha$.[9/] The initial price of output is P. The value of the project can be calculated to be $P/(\lambda+\delta)$ where $\lambda = r + \alpha$. The formula can be understood as follows: (1) λ takes account of the present discounted value adjustment which allows for the time value of money earned in the future and the risk of the project and also of the effect of decreasing price of the service α, and (2) economic depreciation enters with constant rate δ. Note that δ is added to the expression

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8/ The assumption of exponential depreciation rates means that a constant percentage amount of depreciation occurs in each period and is commonly used in economic models.

9/ This factor arises due to changes in demand and changes in total factor productivity.

to account for the economic depreciation, including the decreasing price of capital goods. This term, omitted from most TELRIC calculations, accounts for technological progress in equipment prices, which is one economic factor that leads to lower prices over time. Thus, the value of the project is the initial price P divided by $\lambda + \delta$ which account for the usual discount term r plus the effect of expected change in price α and the expected economic depreciation δ. Taking account of economic depreciation is especially important here, because the MSM model assumes the instantaneous and successive replacement of the network every few years. Thus, depreciation will have a large quantitative effect in the MSM model, if it is done correctly.

Q. What effect on the economically efficient level of investment will omission of economic depreciation have?

A. Suppose that the cost of the investment is I. The rule for a competitive firm is to invest if the value of the project is greater that the cost of the investment or $V(P) > I$. Equivalently from the calculation above, $P > (\lambda + \delta) I$, so that the cost of capital depends on r, the interest rate, and the expected change in price and expected economic depreciation. The economic interpretation of this expression is that the price net of variable cost (*i.e.*, price minus variable cost) must exceed the cost of capital, which includes the change in price of the capital good, to make the investment worthwhile.[10/] Note that the net change in the

[10/] For simplicity, I am assuming only capital costs and no variable costs in this calculation. Variable costs can be included by reinterpreting P to be price minus variable costs, which will lead to the same solution.

output price and the price of the capital good both enter the efficient investment rule. If the price change of the capital good is omitted from the calculation, *i.e.*, the formula uses $\delta = 0$, the TELRIC computed price will be too low. The ILEC will not be able to recover the cost of its investment. The ILEC will then not invest at the economically efficient level because it knows it will not be able to recover its investment cost in the future.

Q. Does the AT&T/WorldCom Modified Synthesis Model consider this factor of economic depreciation?

A. No, the AT&T/WorldCom model takes account of "regulatory depreciation," but it does not take account of the economic depreciation caused by the change in the price of capital goods used in telecommunications. This omission leads to TELRIC-estimated prices that are too low because the price of some capital goods, *e.g.*, fiber, have been decreasing over the past 5 years. Given the MSM model assumption of a "blank slate" replacement of the entire network every few years, the effect of depreciation would be very large, if the model calculation were correct.

Q. Can economic depreciation be important from a quantitative viewpoint in a correct TELRIC calculation?

A. Yes. The prices for central office switches and fiber optic carrier systems have been decreasing over the past five years. The omitted economic factor δ can be quite large relative to r, the traditional ILEC cost of capital used by regulators, for telecommunications switching or transmission equipment due to technological progress.

Thus, omitting the economic factor δ can lead to a significant underestimate of costs. Prices set on the basis of the underestimated costs will be too low, and the ILEC will be required to sell its unbundled elements at a price below its economic cost.

Q. What is the other economic factor that the MSM model calculations omit?

A. The MSM model calculations fail to recognize the sunk and irreversible nature of many investments in telecommunications networks, as I discussed above. The MSM model makes no allowance for the sunk and irreversible nature of telecommunications investment, so that it adopts incorrectly the perfect contestability standard.

Q. Please demonstrate the qualitative effect that sunk investment can have on correct economic calculations.

A. I now account for the sunk nature of the investment and its interaction with fundamental economic and technological uncertainty. Given the fundamental uncertainty and the sunk nature of the investment, a "reward for waiting" occurs because over time some uncertainty is resolved. The uncertainty can arise from at least 4 factors: (1) demand uncertainty, (2) price uncertainty, (3) technological progress (input price) uncertainty, and (4) interest rate uncertainty. These 4 factors lead to a "markup" factor that increases the "cost of capital" in the investment decision that I derived above. The fundamental decision rule for investment becomes:

$$P^s > \frac{\beta_1}{\beta_1 - 1}(\delta + \lambda)I = m\,(\delta + \lambda)I \qquad (1)$$

where $\beta_1 > 1$ so that $m = \beta_1/(\beta_1 - 1) > 1$. The parameter β_1 takes into account the sunk cost nature of the investment coupled with inherent economic uncertainty.[11/] Parameter m is the markup factor required to account for the effect of uncertain economic factors on the cost of sunk and irreversible investments. Thus, the critical cut off point for investment is $P^S > P$. Since the uncertainty increases with time, competitive firms will attempt to recover a greater proportion of their investment "upfront." This effect would lead to regulatory depreciation schedules that provide faster recovery of incumbents' forward-looking costs at the beginning of the relevant period rather than at the end of the period.

Q. Please demonstrate the quantitative effect that sunk investment can have on correct economic calculations.

A. To see how important this consideration of sunk costs can be, I evaluate the markup factor m. This markup factor accounts for the 4 sources of economic uncertainty that I

[11/] I do not derive this equation here since it is the solution to a differential equation. For a derivation, see, e.g., Avinash K. Dixit & Robert S. Pindyck, *Investment Under Uncertainty* 254-56, 279-80, 369 (1994). The parameter β_1 depends on the expected risk adjusted discount rate of r, expected exponential economic depreciation δ, and the net expected price $-\alpha$, as well as the amount of uncertainty in the underlying stochastic process. Note that this result holds under imperfect competition and other types of market structures, not just under monopoly, as some critics have claimed incorrectly. *See, e.g., id.* at 247-81. Imperfect competition is the expected competitive outcome in telecommunications because of the significant fixed and common costs that exist.

discussed previously: (1) demand uncertainty, (2) price uncertainty, (3) technological progress (input price) uncertainty, and (4) interest rate uncertainty. The parameters β_1 and m depend on a number of economic factors. It can be demonstrated that as uncertainty increases, the variance of the underlying stochastic process, β_1,decreases and the m factor increases. Thus, as uncertainty increases, the markup factor m increases, as expected since m accounts for uncertainty. Also, as δ, economic depreciation, increases, β_1 increases, which means that the m factor decreases.[12/] As r, the cost of capital, increases, β_1 decreases so that the m factor increases. Using parameters for LECs and taking into account the decrease in capital prices due to technological progress and because the expected change in (real) prices of most telecommunications services is also negative given the decreasing capital prices, I calculate the value of m to be approximately 3.2-3.4. Thus, a markup factor must be applied to the investment cost component of the MSM model to account for the interaction of uncertainty with sunk and irreversible costs of investment. Depending on the ratio of sunk costs to fixed and variable costs, the overall markup on the rates for individual elements will vary, but the markup will be significant given the importance of sunk costs in most telecommunications investments.

[12/] Some components of loops, *e.g.*, poles, have increased in price over time. While these price increases cause decreased economic depreciation, they increased the markup factor m, using this result.

Q. If the Commission were to use the MSM model, what are some of the changes that would need to be made?

A. First, the deficiencies identified by Dr. Tardiff and Mr. Murphy would need to be addressed (if in fact solving these problems is possible). In so doing, the Commission would have to ensure that the MSM estimate reflected the forward-looking cost of building a real world network, so I would recommend that the Commission actually compare the MSM-assumed network to the real world plans of Verizon VA over a reasonable planning period. Since Verizon VA has the economic incentive to be economically efficient, given price caps regulation, its real world plans should provide valuable information on the economically efficient investment in a real world network.

In addition, to do unbundled element pricing correctly, the two missing elements that I discussed above must be included as a markup over the corrected MSM. A markup for economic depreciation of capital goods must be included. Also, a markup factor that takes account of the effect of risk and uncertainty on the sunk and irreversible nature of much investment in telecommunications networks must be included. These markups are very important for the MSM model, given its extreme assumptions.

Q. What effect would the markup for sunk costs have on a correct forward-looking cost calculation?

A. The markup is applied only to the sunk investment proportion investment of the unbundled element. For switching and ports, Verizon VA estimates that about 40% of the investment is for costs such as engineering, furnishing, and installing, which are all

sunk costs, and that about 50% of the investment in switching material is also sunk. Taken together, then, Verizon VA estimates that sunk costs represent 0.70 (70%) of the estimated total investment for switching and ports. In terms of total TELRIC costs, sunk costs are 0.42 of total costs. The correct markup would then be 0.58 + 3.3*0.42 = 1.97*TELRIC, where I use the 3.3 markup factor that I calculated above. The first term in the equation is the variable costs and fixed (but not sunk) costs and the second term is the sunk costs of investment. Thus, for switching and ports I calculate a markup factor of 1.97 to take account of the sunk and irreversible investment in the unbundled element. In Table 1 I include the calculation for loop markups:

Table 1: Markup Factor Calculation

UNE	Proportion Sunk Costs	Markup Factor
1. Port	0.42	1.97
2. Local Switching	0.42	1.97
3. Loop	0.52	2.20

Thus, a markup factor to take account of sunk costs needs to be included and it varies from 1.97*TELRIC for ports and switching up to 2.20*TELRIC for loops.

Q. Why can't the Commission use the cost of capital observed in the market to adjust for the increased risk created by sunk and irreversible investments?

A. It is important to note that one cannot use the observed cost of capital and claim that the effects of sunk costs are already accounted for since Verizon VA has a substantial proportion of sunk investments that it has been required to sell to CLECs as unbundled

elements. Economic analysis of irreversible investment under uncertainty demonstrates that a given project typically must offer expected returns well above "breakeven," including the cost of capital, before the project is undertaken because of the sunk and irreversible investment as I discussed above. In a contestable world with the availability of costless entry and exit because of the absence of sunk costs, which the MSM model calculations assume, a competitor will enter as soon as the breakeven point is reached because investments are not irreversible under contestability assumptions. Thus, the real world effect of irreversibility is assumed away when contestable markets are assumed.

The market price of risk will only be affected in part by the extra risk created by the obligation to sell unbundled elements to CLECs. Many other services sold by Verizon, *e.g.*, Yellow Pages, would not necessarily be affected in a similar manner by the combination of uncertainty and sunk and irreversible investments. Also, only a relatively small proportion of Verizon VA's network is sold as unbundled elements. It has long been recognized in the finance literature that investment evaluation must be done on a project-specific basis, not on a company-wide basis. Otherwise incorrect decisions can be made. As a well-known graduate finance textbook explains:

> *The true cost of capital depends on the use to which the capital is put.* It is clearly silly to suggest that DEC should demand the same rate of return from a very safe project as from a very risky one. If DEC used the company cost of capital rule, it would reject many good low-risk projects and accept many poor high-risk projects.[13/]

[13/] Richard A. Brealey & Stewart C. Myers, *Principles of Corporate Finance* 182 (4th ed. 1991).

Thus, the risk inherent to investment in specific network elements has to be considered, not the overall risk of Verizon.

Q. Is it true that the criticisms you level here against the MSM model are also applicable to other models performed under TELRIC rules?

A. Any model that fails to take into account sunk costs, thereby placing the risk of stranded investment entirely on the incumbent, should have a risk premium multiplier added to the cost. This problem, however, is particularly acute with the MSM model because of its extreme assumptions of replacing the entire network instantaneously every few years with the newest technology. It is difficult to imagine a more risky scenario for any business in the real world given the high proportion of sunk investment in a real-world telecommunications network.

Q. Does this complete your testimony?

A. Yes, it does.

Declaration of Jerry A. Hausman

I declare under penalty of perjury that the foregoing is true and correct. Executed this 24th day of August, 2001.

Jerry A. Hausman